§12. Electromagnetic Stress and Coupling Loss in Superconducting Cable

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When we evaluate coupling loss in cable conductors, not only the coupling loss in a single strand but also the loss occurred by a current loop including some strands is important. We fabricated sample cables having 2 and 3 strands and some different twist pitches. Contact resistance between the strands in the cable, which was main parameters for quantifying the inter-strand coupling loss, was measured; the dependence of the twist pitches, contact forces and surface conditions on the resistance was studied.

The experimental equipment used in the last year was modified for the study. In the last year, 2 straight strands were stacked with a given intersecting angle, and compressive force was applied at the crossing point. In this year, the compressive force is applied to the whole length of the twisted cable. During the compression process, the contact resistance between the strands, the applied force, and deformation of the cable are measured.

The typical results at liquid helium temperature are shown in Fig. 1. According to the figure, the contact resistance became large with increasing of the twist pitches of the cable.

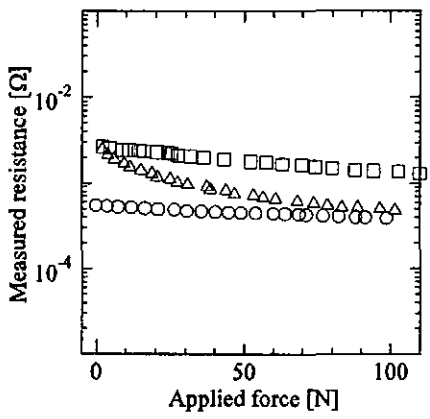

Fig. 1. Measured results of contact resistance in 3-stranded cable with different twist pitches (square: 65 mm, triangle: 50 mm, circle: 25 mm).

Furthermore, we compared the contact resistance between the bare and the Cr-plating surfaces on the strands. The results are shown in Fig. 2. The vertical axis of the figure is the surface resistance which is estimated by the contact resistance and the contact area. As shown in the figure, the surface resistance on the Cr-plating strands is approximately one-order larger than that on the bare-surface strands.

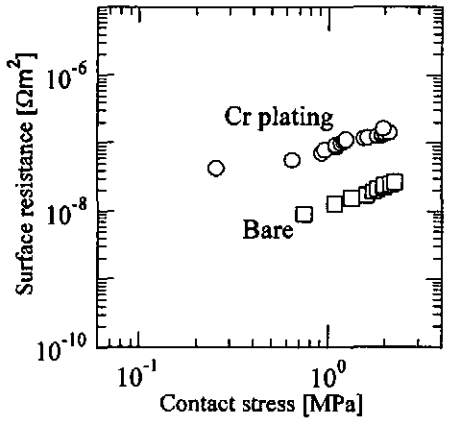

Fig. 2. Estimation of surface resistance of bare and Cr-plating surfaces.

List of publications and presentations:

(1) K. Nakamura, T. Takao, A. Nishimura, T. Mito et al., Influence of intersecting angles of strands on contact resistance in cable-in-conduit conductors, IEEE Trans. on Applied Superconductivity, vol. 13, no. 2, pp. 2392-2395 (2003).
(2) K. Nakamura, M. Yamanouchi, K. Hashimoto, T. Takao, Effects of contact resistance between strands with Cr/Non-Cr coating in cable-in-conduit conductors, IEEE Trans. on Applied Superconductivity (to be published in 2004).
(3) K. Nakamura, T. Takao, A. Nishimura, T. Mito, et al., Relation between contact resistance and strand diameters in cable-in-conduit conductors, presented at EUCAS, Italy (2003).
(4) K. Nakamura, M. Yamanouchi, K. Hashimoto, T. Takao, Measurement of surface resistance on superconducting strands in bundle conductors, presented at ISS, Tsukuba (2003).
(5) K. Nakamura, H. Suko, T. Takao, Relation between contact resistance and twist pitches in superconducting bundle conductors, to be presented at ASC, USA (2004).